

SECTION 23 09 01
FAN CONTROL PANELS

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. This Contract Specifications Section provides requirements for the design, fabrication, configuration, factory testing, delivery to the Jobsite, installation and field testing of the fan control panels (FCPs).

1.02 RELATED SECTIONS

- A. Section 20 40 13, Identification for Facility Services.
- B. Section 20 70 26, Common Materials and Methods for Electrical Systems.
- C. Section 20 72 25, Factory and Field Testing.
- D. Section 20 70 19, Indoor Cabinets, Racks, Frames and Enclosures.
- E. Section 20 80 00, Systems Integration Testing.
- F. Section 23 33 14, Dampers for Station and Tunnel Ventilation.
- G. Section 23 34 14, Fan Motor Units for Station and Tunnel Ventilation.
- H. Section 26 05 13, Medium Voltage Cables.
- I. Section 26 05 24, Low Voltage Wires and Cables.
- J. Section 26 18 42, Medium Voltage Metal-Clad Switchgear.
- K. Section 26 33 01, Battery Systems.
- L. Section 27 60 00, Supervisory Control and Data Acquisition System.

1.03 MEASUREMENT AND PAYMENT

- A. General: Separate measurement or payment will not be made for the work required under this Section. All costs in connection with the Work specified herein will be considered to be included or incidental to the Work of this Contract.

1.04 REFERENCES

- A. Refer to Contract Specification Section 01 42 19, Reference Standards for additional requirements.
- B. The FCP assemblies and related devices shall be designed, manufactured and tested in accordance with the following standards, as applicable:

1. BART:
 - a. Criteria for Supervisory Control and Data Acquisition (SCADA).
2. American National Standards Institute (ANSI):
 - a. C1, Specification of General Requirements of a Quality Program.
 - b. C37.1, Definition, Specification and Analysis of Systems Used for Supervisory Control and Data Acquisition, and Automatic Control.
3. Institute of Electrical and Electronic Engineers (IEEE):
 - a. 730, Standard for Software Quality Assurance Plans.
4. National Electrical Manufacturers Association (NEMA):
 - a. IA 2.3, Programmable Controllers Part 3: Programming Languages (IEC 1131-3).
 - b. ICS-1, General Standards for Industrial Control and Systems.
 - c. ICS-1.1, Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control.
 - d. ICS-2, Industrial Control Devices, Controllers, and Assemblies.
 - e. ICS-4, Terminal Blocks for Industrial Control.
 - f. ICS-6, Enclosures for Industrial Controls and Systems.
5. National Fire Protection Association (NFPA):
 - a. 70 National Electric Code (NEC).
 - b. 101 Life Safety Code.
 - c. 130 Standard for Fixed Guideway Transit and Passenger Rail Systems.
6. Occupational Safety and Health Administration (OSHA)
7. Underwriters Laboratories, Inc. (UL):
 - a. 508, Industrial Control Equipment.

1.05 ABBREVIATIONS

AC	-	Alternating Current
EBP	-	Emergency Backup Panel
FCP	-	Fan Control Panel
ICS	-	Integrated Control System
ICS-V	-	ICS-Ventilation

I/O	-	Input/Output
LED	-	Light Emitting Diode
MPR	-	Multifunction Protection Relay
NO	-	Normally Open
NC	-	Normally Closed
OCC	-	Operations Control Center
PCR	-	Programmable Control Relay
PTC	-	Project Test Center
SCADA	-	Supervisory Control and Data Acquisition
SVF	-	Subway Ventilation Fan
UPS	-	Uninterruptible Power Supply
VCP	-	Ventilation Control Panel

1.06 SUBMITTALS

- A. Provide submittals in accordance with Contract Specifications Section 01 33 00, Submittal Procedures, Contract Specifications Section 01 33 23, Shop Drawings, Product Data, and Samples, Contract Specifications Section 01 42 19, Reference Standards, and the requirements herein. In case of conflict, the more stringent requirement will take precedence.
- B. Listings of the following, "(23 09 01 - XX)", within this Contract Specifications Section represent the identifying designation of the submittals required herein.
- C. The Contractor shall submit names and qualifications of manufacturer of FCP; qualification statement (23 09 01 -1) shall include, but need not be limited to the following data:
 1. Manufacturer's quality assurance programs in accordance with ANSI C1.
 2. Complete list of projects on which similar equipment specified for industrial/transit projects in the United States have been installed for furnished. List shall include:
 - a. Name of authority or user (Include installations of the Owner, if any).
 - b. Contract Number(s).
 - c. Original installation date(s).
 - d. Current condition of equipment.

- e. A list of all known failures including apparent cause(s), corrective work affected, and description of equipment service and operating conditions.
 - 3. List of components to be purchased from other manufacturers. Give name of manufacturer, type and characteristic of each item, and include for each the data requested above.
 - 4. Submit full data sheets, including rating, capacity, manufacturer's type and catalog number for all FCP components, including communications, connectors, termination and patch panels, enclosure and control panel.
 - 5. Submit a list of all inputs and outputs from and to all equipment that interfaces with the FCP. As a minimum this list shall include connections to dampers, fans, motor controllers, power switchgear, SCADA, the ventilation control panel (VCP), operation control center (OCC) etc.
- D. The Contractor shall submit design data and Shop Drawings (23 09 01 - 2) including, but not limited to the following:
- 1. Design data: Submit detailed design drawings as follows:
 - a. Complete development of fan and damper power and control schematics including the FCPs, front panel layouts, programmable relay ladder logic diagrams, monitoring and control schematics, the multifunction protection relay (MPR) I/O list and wiring diagrams.
 - b. Wiring interconnection diagrams between fan motors, damper module actuators, fan starters, MPRs, FCPs and the SCADA system interface in cabinet 44F.
 - c. FCP Construction details.
 - 2. Shop Drawings shall include, but not be limited to, the following:
 - a. Each FCP showing materials and methods of construction, door arrangement, conduit hub and knockout locations, enclosure type, complete internal wiring diagrams, mounting locations and supports for equipment mounted in the panels and cabinets, terminal strip designations, and wire numbers.
 - b. Each FCP dimensioned plans, elevations, sections, weight, and full mounting details, including required clearances, removable plates or openings and service space around equipment of all components.
 - c. Product Data: Submit manufacturer's product data for manufactured items as follows:
 - 1) Manufacturer's model number or item identification;
 - 2) UL listing and rating;
 - 3) Critical dimensions and mounting arrangement; and
 - 4) Complete replacement parts list.
 - d. Each FCP control panel showing layout of pushbuttons and indications.

- e. Terminal-to-terminal and full inter-connection drawings between FCP, MCC and dampers for each FCP.
- f. Fiber Optic (where applicable):
 - 1) Submit link loss in dBm for each fiber and associated connectors in both directions.
 - 2) Submit data loss margin for each fiber.
- E. The Contractor shall submit the quality assurance, quality control submittals (23 09 01 - 3) in accordance with Contract Specifications Section 01 43 00, Quality Assurance; including, but not limited to, the following:
 - 1. Test programs for factory and site tests shall be submitted with samples of all test report forms before testing takes place. The District Representative reserves the right to attend all tests and shall be notified not less than 4 weeks before the intended test dates.
 - 2. The test report shall identify the name of manufacturer, model numbers, serial numbers, and the last date of calibration of test instrumentation. Documentation shall be furnished to verify that test instruments have been calibrated not more than nine months before the tests.
 - 3. Factory Tests shall be carried out on all FCP's and shall include:
 - a. Check of control and power wiring, correct connections against the drawings, insulation resistance and freedom from shorts and grounds.
 - b. Functional checking of circuit operation, including relay circuits and operation of switches, push buttons and indications.
 - c. Simulate communications to SCADA.
- F. The Contractor shall submit seismic calculations (23 09 01 - 4) to show compliance with the requirements of the Contract. Submittals shall be signed and sealed by a Registered Professional Structural Engineer Licensed in the State of California.
- G. A minimum of 60 Days prior to the commencement of factory testing, the Contractor shall submit a detailed testing plan for Factory Testing (23 09 01 - 5). Factory test plans and reports shall be in accordance with Contract Specifications Section 20 72 25, Factory and Field Testing and Contract Specifications Section 20 80 00, Systems Integration Testing.
- H. 60 Days prior to the field testing, the Contractor shall submit a detailed testing plan for Field Testing (23 09 01 - 6). Field test plans and reports shall be in accordance with Contract Specifications Section 20 72 25, Factory and Field Testing and Contract Specifications Section 20 80 00, Systems Integration Testing.
- I. The Contractor shall submit recommended spare parts list and special tools list (23 09 01 - 7) in accordance with the Contract Specifications Section 01 78 44, Spare Parts and Maintenance Manuals.

- J. Within 30 Days of successfully completing factory testing, the Contractor shall submit a test report with all of the factory testing results (23 09 01 - 8)
- K. Within 30 Days of successfully completing field testing, the Contractor shall submit a test report with the entire field testing results (23 09 01 - 9) including certified reports of electrical continuity, insulation, and ground continuity tests performed on installed products.
- L. Within 45 Days of successfully completing field testing, the Contractor shall submit Certifications (23 09 01 - 10): A factory-trained manufacturer's representative(s) shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.
- M. Closeout submittals
1. The Contractor shall furnish an Operations and Maintenance (O&M) Manual covering each piece of equipment. The O&M Manual shall include the names, addresses, and telephone numbers of each Subcontractor furnishing or installing equipment and of the local representatives of the manufacturer of each item of equipment. The O&M Manual shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject. The instruction sheets shall be legible with large sheets of drawings folded in.
 2. The O&M Manual shall provide a clear explanation of the theory, operation, and maintenance of the equipment accompanied by photos and schematic, wiring and mechanical assembly diagrams, as required. The O&M Manual shall be indexed and cross-referenced in an easily understood manner. The O&M Manual shall be loose leaf bound and shall include, but not necessarily be limited to, the following information:
 - a. Operating instructions.
 - b. Troubleshooting and fault isolation procedures for on-site level repair.
 - c. A preventive maintenance schedule for inspection, removal and replacement for each component.
 - d. Recommended spare parts list for one year's operation.
 - e. Bill of Material.
 - f. Equipment manufacturer's' descriptive literature including catalog cuts.
 - g. (As Built) Record Drawings.
 - h. Acceptance factory test reports.
 - i. Data loss margin for each fiber optic link.
- N. Prior to Substantial Completion the Contractor shall submit Operations and Maintenance Manuals (CDRL WSXDB - 23 09 01 - 11) in accordance with Contract Specifications Section 01 78 23, Operations and Maintenance Data.

- O. Prior to Substantial Completion the Contractor shall submit training materials in accordance with Contract Specifications Section 01 79 00, Demonstration and Training.
- P. Prior to Substantial Completion the Contractor shall submit a recommended spare parts list in accordance with Contract Specifications Section 01 78 44, Spare Parts and Maintenance Manuals.
- Q. Record Drawings: Submit Record Drawings in accordance with Contract Specifications Section 01 78 39, Contract Record Documents.
- R. Prior to Substantial Completion the Contractor shall submit Warranty Certificates (CDRL WSXDB - 23 09 01 - 12).

1.07 QUALITY ASSURANCE AND QUALITY CONTROL

- A. Refer to Contract Specifications Section 01 43 00, Quality Assurance, and Contract Specifications Section 01 45 00, Quality Control, for hardware quality assurance requirements and IEEE STD 730 for software quality assurance requirements.
- B. Electrical Components, devices, and accessories shall be listed and labeled as defined in NFPA 70 Article 100. All components shall be UL Listed.
- C. Conform to applicable requirements of the California Electrical Code and NFPA 130.
- D. Components of the same type, size, rating, functional characteristics, and manufacture shall be interchangeable.
- E. Controls and auxiliary devices shall be tested and certified in accordance with NEMA ICS 2. Certificate of compliance shall be submitted before assembled equipment is shipped.
- F. The manufacturer of the FCP's must have a minimum of five years of successful and proven industrial/transit experience of providing equipment similar to the one being furnished under this Contract.
- G. Auxiliary equipment, devices, and components comprising the FCP's shall be proven standard products, or equivalent to the standard products of manufacturers engaged in the production of such equipment, devices, and components for at least the past five years.
- H. Field testing shall be performed by persons having five or more years of relevant testing experience.
- I. Qualifications:
 - 1. Manufacturer's Qualifications: Contractor shall ensure that the manufacturer submits documents to show continuous and current experience in the design, manufacture, assembly, and testing of electrical and electronic control panels and has met all UL requirements.

2. Certified Fiber Optic Technician qualification shall be submitted and approved before work commences.

- J. Quality Control Plan: Contractor shall ensure that the manufacturer submits its quality control plan, showing that functional checking on each panel is checked and verified.

1.08 SYSTEM DESCRIPTION

- A. The FCPs shall be used to control, protect and monitor the subway ventilation fans and dampers at the ventilation structures. The tunnel ventilation system is part of the fire life safety system for the operation of BART system.
- B. A manual local/remote switch is provided on each FCP. In local mode, fans can only be controlled at the FCP with thermal protection and other protective devices enabled. Local operation from the FCPs is intended for maintenance and test purposes only. In remote mode, fans can be started from the VCP or from the OCC workstations. When the switch is moved to the remote position the system shall be in emergency mode (No protective devices enabled).
- C. The FCP shall have provisions for a remote maintenance mode. This mode shall be implemented from the OCC workstations and shall allow the operation of the tunnel ventilation system in a maintenance mode (with thermal and other protective devices operational). This maintenance shall not be the default mode of operation. The default mode shall always be the emergency mode.
- D. Control of fans and dampers at the VCP or the OCC workstations is by manual fan supply/exhaust/stop or damper open-close commands. In addition, group commands (i.e., multiple fan/damper commands) can be issued from the OCC workstations. In addition to manual control, control by the integrated computer system (ICS) and ICS-V workstations is via scenarios, where the software determines which fan/dampers should operate based on train location, length of the train and location of the smoke/fire event. Based on these user inputs, individual fan/damper controls are sent to the vent structure SCADA PLC located in cabinet 23F.
- E. All fans and damper commands sent to a vent structure PLC are momentary. Momentary commands are transferred to the fan starter control circuit where the command is latched by an interposing relay. A contact of the interposing relay is inserted in the fan starter coil circuit along with other fan start permissives such as "damper open" and "permission to start". The interposing relay is unlatched when the fan run contact is activated. In emergency mode (the default mode) nothing shall interfere with starting of the emergency ventilation fans.
- F. Ventilation control is interlocked such that the ventilation equipment is controlled only from one location at anytime. Ventilation control defaults to the OCC but the VCP can take control at any time from OCC. Once a VCP is in control, the OCC can regain control only after the VCP relinquishes control, or if the VCP does not respond after a timeout. Monitoring functions are provided continuously to all systems and are not affected by the interlocking.

- G. The FCP shall provide starting of tunnel ventilation fans per the requirements of the latest revision of the BART Facilities Standard (BFS).

1.09 DELIVERY, STORAGE AND HANDLING

- A. Refer to Contract Specification Section 01 60 00, Product Requirements for additional requirements.
- B. Suitable crating, blocking, and supports shall be provided so equipment will withstand expected domestic shipping and handling shocks and vibration.
- C. Equipment shall be weatherproofed for shipment. Connection openings shall be closed to prevent entrance of foreign material during shipment and storage. Internal packing material shall be clearly identified for removal.
- D. Equipment shall be handled and sorted in conformance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at time of shipment. FCP shall be stored indoors in a dry location to prevent moisture damage. FCP shall be stored in a location where it is protected from physical damage as well as vermin.
- E. Design shipping groups to be shipped by truck, rail, or ship. Additionally ensure shipping groups will fit through the proposed doorways/openings (reference Contract Drawings) without requiring disassembly and reassembly on site. Bolt indoor groups to skids.
- F. Acceptance at Jobsite: Equipment shipping paperwork shall include a copy of the certified successful factory testing of the equipment prior to acceptance of the shipment at the Jobsite.

1.10 CONTRACT/JOBSITE CONDITIONS

- A. The FCP shall be designed for operation under the following environmental conditions.
 - 1. Ambient temperature: 10 to 122 degrees Fahrenheit.
 - 2. Relative humidity: five to 95 percent relative humidity.

1.11 WARRANTY

- A. Refer to General Conditions and Supplementary Conditions for additional requirements.
- B. The Contractor shall ensure that in addition to the Guaranty provisions of General Conditions Article GC4.9, a warranty for the FCP's components is provided and signed by the equipment manufacturer and the Contractor agreeing to correct system deficiencies and replace components that fail in materials or workmanship.

PART 2 – PRODUCTS

2.01 FCP CABINETS

- A. Wall-mounted FCP cabinets shall conform to Contract Specifications Section 20 70 19, Indoor Cabinets, Racks, Frames and Enclosures. The type of enclosure for the FCP shall be NEMA 12.

2.02 PROGRAMMABLE CONTROL RELAYS

- A. Programmable control relays (PCRs) shall be the Easy800 series as manufactured by Moeller or equal. PCRs shall be equipped with sufficient discrete input/output I/O points plus 10 percent spares to satisfy the connections to the associated fan and damper modules, fan starter, MPR, SCADA system and the control and indicating devices on the FCP front panel. The I/O capacity shall be met by using an I/O expansion unit connected to the PCR and/or a second linked PCR with an expansion unit if required.
- B. PCR power supplies shall be rated for 120 VAC and powered by the local uninterruptible power supply (UPS).
- C. PCR programming software shall be the latest version of Easy-Soft, or equal.

2.03 FCP COMPONENTS

- A. Terminal blocks shall be double-row collar type screw terminals with spring action overlapping top plates rated for 30 amperes, 600 volts with barrier strips between each adjacent row of terminal positions. Terminal blocks shall conform to NEMA ICS-4 and UL 50. Each terminal shall have a white marking strip and plastic cover. Provide 25 percent spare terminals. Mount terminal blocks securely to bracket assembly with stainless steel screws and washers. Terminals shall be grouped and segregated for different operating voltages.
- B. Cable and Wiring: Cable and wiring shall comply with Contract Specifications Section 26 05 24, Low Voltage Wires and Cables. In order to meet the requirements of NFPA 130, use type RHW (two hour rated) cable for all field cables running from the equipment to the FCP in ducts/plenum. All cable running at track level shall have a low-smoke outer jacket such as polyolefin.
- C. Nameplates to comply with the requirements of Contract Specifications Section 20 40 13, Identification for Facility Services.
- D. Indicating Lights, Pushbuttons and Selector Switches:
 - 1. Indicating lights, pushbuttons and selector switches shall be 30mm pilot devices.
 - 2. Indicating lights shall use light emitting diode (LED) lamps. The LED lamps shall be replaceable from the front, rated for 120 VAC and 100,000 hours at full voltage, and shall be clearly visible at an angle of 30 degrees and at a distance of 15 feet in a fully lit environment. Colors shall be red or green as shown.

3. Pushbuttons shall be mushroom type, non-illuminated with momentary operators and NO and NC contacts as required. Mushroom buttons shall be red or green as shown.
4. Selector switches shall be two-position, maintained, lever versions or three-position, spring return, knob versions as shown.

PART 3 – EXECUTION

3.01 FCP CONFIGURATION

- A. Configure the PCR data base to accommodate the FCP I/O requirements as shown on the Contract Drawings.
- B. Configure the PCR control logic to satisfy the following requirements:
 1. When a fan start command is issued, either locally or remotely, the FCP shall issue an open command to the fan damper modules and shall issue a start command to the fan starter. If the FCP is in local or a maintenance mode has been activated and the fan damper modules fail to open an indication shall be issued to OCC and the fan shall be shut down.
 2. Fan running status, either supply or exhaust, shall be based on satisfying five parameters: fan contactor closed, fan current exceeds a preset set point, phase rotation is indicated correctly and the fan motion detector senses that the impellor direction of rotation and speed exceeds a preset setpoint.
 3. Fan stopped status shall be determined by verifying that both fan contactors are deenergized.
 4. If one or more damper modules do not provide a fully open or closed indication, a damper trouble alarm shall be generated.
 5. When in emergency mode, and a remote fan start command is received, the FCP shall transmit a contact closure to the fan starter to bypass the fan and damper motor overloads, vibration and temperature sensors protection devices and the damper modules fully closed indication and start the fan.
 6. In the local or maintenance operation mode, if the fan locked rotor current occurs for 30 seconds as detected by the fan's multifunction protection relay (MPR), close the fan's damper and shutdown the fan.
- C. Equipment shall be installed in accordance with the approved Shop Drawings and the respective equipment manufacturer's installation instructions and recommendations.

3.02 FACTORY TESTS

- A. Perform factory tests in accordance with the requirements specified in Contract Specifications Section 20 72 25, Factory and Field Testing. The witnessed factory test shall be performed on one FCP.
- B. A discrete input hardware simulator shall be used to simulate all inputs from field equipment and SCADA. Discrete outputs shall be verified by observing the LEDs on the PCR discrete output modules and, where applicable, the status and alarm indicating lights on the FCP front panel.

3.03 INSTALLATION

- A. Install the FCPs in accordance with Contract Specifications Section 20 70 19, Indoor Cabinets, Racks, Frames and Enclosures.
- B. Following the installation of all related equipment including fans, fan starters, MPRs, SCADA cabinet 44 degrees Fahrenheit, etc., terminate all connections as indicated on the plans and the approved Shop Drawings.

3.04 FIELD TESTING

- A. Test all wiring in accordance with Contract Specifications Section 26 05 24, Low Voltage Wires and Cables.
- B. Verify the correct termination of all field wiring using Contractor-prepared interconnection diagrams.
- C. Perform functional tests of each FCP in local control mode including the starting and stopping of the fan and opening and closing the damper. Simulate abnormal conditions and verify that the information is correctly displayed on the FCP. Verify that the information is correctly displayed on the workstations in the Project Test Center (PTC). Testing shall be coordinated with the functional SCADA system requirements specified in Contract Specifications Section 27 60 00, Supervisory Control and Data Acquisition System.
- D. Perform functional tests of each FCP in remote control mode including the manual starting and stopping of the fan and opening and closing the damper from the PTC. Verify that fan and damper motor protection is bypassed in Emergency mode. Verify that all devices are functioning properly.

END OF SECTION 23 09 01